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U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/980027

INTERNATIONAL APPLICATION NO.  
PCT FR00/01448

INTERNATIONAL FILING DATE  
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TITLE OF INVENTION

A BANDPASS FILTER WITH CARRIER FREQUENCY REDUCTION

APPLICANT(S) FOR DO/EO/US

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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1.  This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371
2.  This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3.  This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b)) and PCT articles 22 and 39(1).
4.  A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5.  A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a.  is transmitted herewith (required only if not transmitted by the International Bureau).
  - b.  has been transmitted by the International Bureau.
  - c.  is not required, as the application was filed in the United States Receiving Office (RO/US).
6.  A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7.  Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
  - a.  is transmitted herewith (required only if not transmitted by the International Bureau).
  - b.  have been transmitted by the International Bureau.
  - c.  have not been made; however, the time limit for making such amendments has NOT expired
  - d.  have not been made and will not be made.
8.  A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9.  An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10.  A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11.  An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12.  An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13.  A **FIRST** preliminary amendment.  
 A **SECOND** or **SUBSEQUENT** preliminary amendment.
14.  A subsequent specification.
15.  A change of power of attorney and/or address letter.
16.  Other items or information:

copy of the Preliminary examination report(w/out amendments); English translation of this report; copy of forms PCT/IB301 & 304; 2 sheets, 5 figures; *request for priority*.

US

## Annex US.II, page 2 PCT Applicant's Guide - Volume II - National Chapter - US

U.S. APPLICATION NO (if known) <i>09/980027</i>	INTERNATIONAL APPLICATION NO PCT FR00/01448	ATTORNEY'S DOCKET NUMBER 15675p382		
<p>17. <input checked="" type="checkbox"/> The following fees are submitted:</p> <p><b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5) ):</b></p> <p>Neither international preliminary examination fee (37 CFR 1.482 nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by EPO or JPO ..... \$1040.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO. .... \$890.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$740.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) .... \$710.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$100.00</p>		<b>CALCULATIONS FOR PTO USE ONLY</b>		
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>		\$ 890.00		
<p>Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).</p>		\$		
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	11 - 20 =	0	X \$18.00	\$ 0.00
Independent claims	2 - 3 =	0	X \$84.00	\$ 0.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		+ \$280.00	\$ 280.00	
<b>TOTAL OF ABOVE CALCULATIONS =</b>		\$ 1170.00		
<p>Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).</p>		\$		
<b>SUBTOTAL =</b>		\$ 1170.00		
<p>Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).</p>		\$		
<b>TOTAL NATIONAL FEE =</b>		\$ 1170.00		
<p>Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property</p>		+ \$		
<b>TOTAL FEES ENCLOSED =</b>		\$ 1170.00		
		\$ Amount to be: refunded	\$	
		charged	\$	
<p>a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>1170.00</u> to cover the above fees is enclosed.</p> <p>b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.</p> <p>c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>022666</u>. A duplicate copy of this sheet is enclosed.</p>				
<p><b>NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b></p>				
<p>SEND ALL CORRESPONDENCE TO:</p> <p><b>Blakely, Sokoloff, Taylor &amp; Zafman LLP</b> 12400 Wilshire Blvd. 7th Floor Los Angeles, CA 90025-1026</p>				
 <b>SIGNATURE</b> <b>Eric S. Hyman</b> <b>NAME</b>				
<u>30,139</u> <b>REGISTRATION NUMBER</b>				

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UTILITY APPLICATION FOR UNITED STATES PATENT  
FOR

**A BANDPASS FILTER WITH CARRIER FREQUENCY REDUCTION**

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26 NOV 2001

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A BANDPASS FILTER WITH CARRIER FREQUENCY REDUCTION

The invention relates to analog bandpass filters, and more particularly to those which present high selectivity at high frequencies, typically several 5 hundreds of megahertz (MHz).

The invention thus relates in particular to front end architectures for receivers or transmitters of radio frequency (RF) signals.

One of the applications of the invention lies in 10 integrating an analog portion of a GSM type mobile terminal receiver, where the purpose of the analog portion is to amplify the signal received by the antennas at a very high frequency, so as to select a frequency band of interest to the user of the terminal, and so as 15 to reduce this frequency band to a low frequency.

In conventional manner, a frequency band is selected by filtering. The usual integrated filtering does not enable very high quality (Q) factors to be obtained. In order to select a narrow band corresponding to the 20 frequency band of a user, it is therefore generally necessary either to use an external filter known as a surface acoustic wave (SAW) filter or to decrease the carrier frequency of the signal.

Such an operation of decreasing the carrier 25 frequency, known as frequency transposition, is generally performed by means of analog multipliers. One of the major problems with such frequency transposition lies in the formation of an image frequency in addition to the desired signal. That is why known devices do not make it 30 simple to decrease frequency without using an external filter (in particular a SAW filter) which serves to eliminate the image frequency.

To make a narrow filter for a channel situated at 35 high frequency, French patent application FR 95/05847 proposes a circuit such as that shown in Figure 1 in which the same input signal for filtering is subjected to a frequency transposition on each of two parallel

branches, followed by lowpass filtering and followed by further frequency transposition to the original frequency of the input signal. In order to prevent the image frequency from being folded into the working channel, the 5 four transpositions that are performed make use of only two signals which are in phase quadrature, and each of these two signals is applied to each of the two branches in a cross-over configuration enabling any phase shift differences to be compensated.

10 That document also proposes using an RC-CR phase shifter of the kind shown in Figure 2, which guarantees that the two signals are in quadrature. Nevertheless, when the frequency of an oscillator placed at the input of the phase shifter is slightly different from the 15 cutoff frequency of the phase shifter, then the two output signals are not equal in amplitude.

That phenomenon is compensated in the prior art device by crossing over the quadrature signals within the circuit.

20 Such crossing over of quadrature signals within a bandpass filter structure is also proposed in "A high-Q 200 MHz low-power fully-integrated bandpass IF filter", CICC'98.

25 Although those circuits enable filtering to be performed at a very high frequency, they do not enable the carrier frequency of the signal to be decreased (for a receiver) or increased (for a transmitter), even though four multipliers are used.

30 The object of the invention is to propose a method and apparatus for narrow filtering of a high frequency signal, also enabling the carrier frequency of the signal to be reduced while making use of a small number of multipliers only.

35 This result is obtained with a bandpass filter method in which two frequency transpositions of an input signal for filtering are performed in parallel, making use respectively of a first mixing signal and of a second

mixing signal which mixing signals are substantially in phase quadrature so as to obtain respective first and second transposed signals. The two transposed signals are filtered by two respective lowpass filters (with the 5 transposition signals being at a frequency and with the lowpass filters having a passband that are associated respectively with the frequency of the input signal and with the passband desired for the bandpass filter). Thereafter, respective frequency transpositions are 10 performed on the first and second filtered transposed signals using two respective output mixing signals, and the sum or the difference of the two signals obtained in this way is taken. These transpositions are characterized in that the output mixing signals are 15 selected to be different in frequency from the first and second transposition signals so that the output signal lies in a desired frequency range.

To achieve this object, the invention also provides a bandpass filtering method in which two frequency 20 transpositions are performed in parallel on an input signal for filtering using respective first and second upstream mixing signals that are substantially in phase quadrature so as to obtain respective first and second transposed signals, and the two transposed signals are 25 filtered respectively by two lowpass filters, the frequency of the transposition signals and the passband of the low-pass filters being related to the frequency of the input signal and to the passband desired for the bandpass filter, then respective frequency transpositions 30 are performed on the first and second filtered transposed signals using two respective downstream mixing signals, and the sum or the difference of the two signals obtained in this way is taken, the frequency of the output mixing signals is selected to be different from the frequency of 35 the first and second mixing signals so that the output signal is transposed into a desired frequency range, the method being characterized in that a common oscillator is

used which is coupled with a first phase shifter to produce the upstream mixing signals and which is coupled with a second phase shifter to produce the downstream mixing signals, and in that the phase shifters are used  
5 in opposite manner on the first and second signals so that each of said first and second signals receives the phase-advanced output signal from one of the two phase shifters and the phase-delayed output signal from the other of the two phase shifters.

10 Other characteristics, objects, and advantages of the invention will appear on reading the following detailed description given with reference to the accompanying drawings, in which:

15 - Figure 1 shows the above-mentioned state-of-the-art circuit;

- Figure 2 shows the above-mentioned state-of-the-art RC-CR circuit;

- Figure 3 is a schematic of a circuit of the invention;

20 - Figure 4 is a schematic of an upstream phase shifter for the Figure 3 circuit; and

- Figure 5 is a schematic of a downstream phase shifter for the Figure 3 circuit.

25 As shown in Figure 1, the prior art bandpass filter of bandwidth equal to B comprises an input terminal BE for receiving an input signal SE of angular frequency  $\omega_e$ , and two parallel processing paths VT1 and VT2. Each processing path has an upstream mixer MA1 (MA2) followed by a lowpass filter F1 (F2) connected to a downstream mixer MV1 (MV2). The respective outputs from the downstream mixers are connected to two inputs of a subtracter STR whose output is connected to the output terminal BS of the filter.

30 Transposition means MT are also provided, delivering two mixing signals SM1 and SM2 of angular frequency  $\omega_0$ , and substantially in phase quadrature. The first mixing signal SM1 is delivered to the upstream mixer MA1 and the

resulting transposed signal ST1, after being filtered by the filter F1, gives a filtered transposed signal STF1 which, after being transposed in the downstream mixer MV1 using the second mixing signal SM2 delivers a 5 retransposed signal STFT1 to one of the inputs of the subtracter STR.

Similarly, the second mixing signal SM2 is delivered to the upstream mixer MA2 so as to enable the transposed signal ST2 to be obtained and, after filtering, the 10 filtered transposed signal STF2. This signal STF2, after being transposed in the downstream mixer MV2 using the first signal SM1, provides the retransposed signal STFT2 which is delivered to the other input of the subtracter STR.

15 After the difference has been taken between the two signals STFT1 and STFT2, the output signal SSF is stripped of the undesired sideband centered on angular frequency  $2\omega_0 - \omega_e$ , which is equivalent to eliminating the influence of the image signal from the input signal.

20 As shown in Figure 3, the bandpass filter of the invention reproduces the same general structure with two parallel processing paths VT1 and VT2, each having an upstream mixer MA1 (MA2) followed by a lowpass filter F1 (F2) connected to a downstream mixer MV1 (MV2).

25 The respective outputs from the downstream mixers are connected to the two inputs of a subtracter STR whose output is connected to the output terminal BS of the filter. In this circuit, likewise, the upstream mixers receive transposition signals in phase quadrature SM1 and 30 SM2, and the two downstream mixers MV1 and MV2 likewise receive two transposition signals in phase quadrature.

Assuming, for simplification purposes, that the mixing signals delivered to the mixers MA1 and MA2 are respectively of the form  $\sin(\omega_0 t)$  and  $\cos(\omega_0 t)$ , and that 35 the angular frequency of the input signal SE is  $\omega_i$ , then the signals present at the outputs of these mixers present a first frequency band centered around angular

frequency  $(\omega_i - \omega_0)$ , and a second frequency band centered around angular frequency  $(\omega_i + \omega_0)$  which is eliminated by the lowpass filters F1 and F2.

5 The frequency  $\omega_0$  and the bandwidth  $B/2$  of the lowpass filters F1 and F2 are selected in such a manner that the following relationship is satisfied:

$$B > 2|\omega_0 - \omega_i|$$

10 In other words,  $\omega_0$  is selected so as to achieve frequency transposition that matches the working frequency band which is to be filtered, with the upper limit B depending on the desired selectivity.

15 On output from the lowpass filters F1 and F2, the signals in the two branches are subjected to frequency transposition by multiplication with signals oscillating at angular frequency  $\omega_1$ .

20 The two transposition signals applied to the upstream mixers are at an angular frequency  $\omega_0$  which is different from the angular frequency  $\omega_1$  of the two transposition signals applied to the downstream mixers.

25 The signals obtained at the output from the downstream mixers in each of the two branches then present a first frequency band centered around the angular frequency  $(-\omega_i + \omega_0 + \omega_1)$  and a second frequency band centered around the angular frequency  $(\omega_i - \omega_0 + \omega_1)$ .

30 The signals SMV1 and SMV2 injected respectively into the downstream mixers MV1 and MV2 are in phase quadrature, as are the signals SM1 and SM2 injected into the mixers MA1 and MA2, so one of the components of each signal reaching one of the two inputs of the subtracter STR cancels with the corresponding component of the signal reaching the other input of the subtracter. The remaining one of the two components in each signal adds with the remaining component in the other signal. Thus, a single frequency band is obtained at the output from 35 the subtracter STR, and in this case the band centered on angular frequency  $(\omega_i - \omega_0 + \omega_1)$ .

By a suitable choice of  $\omega_1$ , it is possible to obtain a frequency band centered on a desired working frequency.

To deliver the quadrature signals SM1 and SM2 and the quadrature signals SMV1 and SMV2, the present 5 embodiment proposes connecting the input of the upstream mixers to a unit comprising an oscillator LO at the frequency  $\omega_0$  in association with an RC-CR type phase shifter MTV as shown in Figure 4. This phase shifter MTV comprises two phase shifting cells CD1 and CD2 disposed 10 respectively between the output of the local oscillator LO and each of the two processing paths VT1 and VT2.

The first phase shifting cell CD1 is a capacitive-resistive cell comprising a capacitor C having one terminal connected to an output of the oscillator LO and 15 having its other terminal connected to ground via a resistor R. The other phase shifting cell CD2 is a resistive-capacitive cell comprising a same-resistance resistor R with one terminal connected to the output of the oscillator LO and its other terminal connected to 20 ground via a capacitor C identical to that of the cell CD1.

After passing through the phase shifting cell CD1, the signal SL output by the local oscillator LO is subject to a phase shift of  $90^\circ - \theta$  (e.g.  $45^\circ$ ) as defined 25 by the product  $R \times C$  so as to deliver the first mixing signal SM1. Since the resistance and capacitance R and C of the cell CD1 and of the cell CD2 are identical, the cell CD2 serves to deliver a second mixing signal SM2 of phase shift equal to  $-\theta$  relative to the output signal 30 from the oscillator LO.

The downstream phase shifter MTV receives an input sinewave signal at an angular frequency  $\omega_1$ . This input signal is generated by frequency division from the signal output at  $\omega_0$  by the oscillator LO, using a conventional 35 type of frequency divider.

In a variant, the two input signals for the phase shifters, respectively at  $\omega_0$  and at  $\omega_1$ , can both be

obtained by frequency division from a signal output by an oscillator, with the two division ratios naturally being different.

5 The ratio between the two frequencies  $\omega_0$  and  $\omega_1$  is known accurately, and is equal to a rational number, i.e. to a ratio of two integers.

10 The downstream phase shifter MTV is similar in structure to the upstream phase shifter MTM, as can be seen in Figure 5. For this second phase shifter, two capacitors  $C'$  are used, each having capacitance equal to  $mC$  where  $m$  is an integer. The two resistors  $R'$  of this phase shifter each has resistance equal to  $nR$  where  $n$  is an integer.

15 In a variant, the ratio  $m$  between  $C'$  and  $C$  can be a rational number, as can the ratio  $n$  between  $R'$  and  $R$ .

20 The resistances and the capacitances in the circuits MTM and MTV are selected so that the cutoff angular frequencies of each of these two circuits are equal to the angular frequencies of the signals they receive at their respective inputs, so as to obtain the same gain in both filtering paths VT1 and VT2 for both phase shifters.

25 The resistors and capacitors in the second phase shifter MTV thus have resistances and capacitances  $R'$  and  $C'$  selected so that the ratio  $R'C'/RC$  is equal to the ratio  $\omega_0/\omega_1$  of the angular frequencies of the signals delivered to said two phase shifters MTM and MTV. The ratio  $\omega_0/\omega_1$  is thus equal to a ratio of integers.

30 The phase shifters MTM and MTV are positioned in opposite manner so that each parallel branch VT1 and VT2 receives a phase-advanced signal on one of its phase shifters and a phase-delayed signal on its other phase shifter. In order to simplify, each of the phase shifters is assumed to deliver a sine signal and a cosine signal, with the disposition of the phase shifters being 35 such that each branch VT1 or VT2 receives a sine signal on one of its phase shifters and a cosine signal on its other phase shifter. Each branch is connected to the R-C

cell of one of the phase shifters and to the C-R cell of the other phase shifter.

Because the input signals to the phase shifters are supplied from a common oscillator LO, in the event of 5 either of the two frequencies  $\omega_0$  and  $\omega_1$  being slightly offset, then the same offset will appear on the other one of said two frequencies, so both phase shifters will present an amplitude difference between their respective outputs that is the same. Since the phase shifters are 10 oppositely positioned, each branch receives one amplified signal and one attenuated signal, such that any amplitude differences due to possible frequency variations of the oscillators is compensated within each branch and this compensation is effective over a wide frequency band.

15 Advantageously,  $\omega_0$  and  $\omega_1$  are selected in such a manner that the value of  $\omega_0$  is equal to a rational number multiplied by the value of  $\omega_1$ . Thus, the desired ratio between the resistances in the two phase shifters and the 20 desired ratio between the capacitances in the two phase shifters are rational numbers that can be obtained easily and accurately with techniques that are conventional in manufacturing integrated circuits. Furthermore, by using a ratio that is equal to a rational number for the cutoff 25 frequencies, any difference in amplitude between sine and cosine is particularly similar in both phase shifters (ignoring errors in block matching, which will in any event be limited because of the integer ratio).

30 Provision is also made for these phase shifters to adopt a frequency ratio equal to an integer ratio and to adopt resistances and capacitances as a function of the integers constituting the ratio.  $C$  and  $C'$  can be selected to be equal and the resistances  $R'$  and  $R$  can be selected so that  $R'/R$ , i.e.  $\omega_0/\omega_1$  is an integer number or a rational number. Similarly,  $R$  and  $R'$  can be selected 35 to be equal and  $C$  and  $C'$  can be selected in such a manner that  $C'/C$ , i.e.  $\omega_0/\omega_1$  is equal to an integer number or a rational number.

In addition, by making both phase shifters by using a similar succession of steps on each occasion, any difference in cutoff frequency or in phase shift value due to imperfection in manufacture will arrive in similar manner in both circuits, such that the difference will be compensated because these circuits are crossed-over.

The use of RC-CR type phase shifters nevertheless enables good phase accuracy to be obtained.

The invention thus makes it possible to facilitate complete integration of the analog portion of a receiver within an integrated circuit.

## CLAIMS

1/ A bandpass filtering method in which two frequency transpositions are performed in parallel on an input signal (SE) for filtering using respective first and second upstream mixing signals (SM1, SM2) that are substantially in phase quadrature so as to obtain respective first and second transposed signals (ST1, ST2), and the two transposed signals are filtered respectively by two lowpass filters (F1, F2), the frequency of the transposition signals ( $\omega_0$ ) and the passband (B/2) of the low-pass filters being related to the frequency of the input signal ( $\omega_e$ ) and to the passband desired for the bandpass filter, then respective frequency transpositions are performed on the first and second filtered transposed signals (STF1, STF2) using two respective downstream mixing signals, and the sum or the difference of the two signals obtained in this way is taken, the frequency of the output mixing signals (SMV1, SMV2) is selected to be different from the frequency of the first and second mixing signals so that the output signal is transposed into a desired frequency range, the method being characterized in that a common oscillator (LO) is used which is coupled with a first phase shifter (MTM) to produce the upstream mixing signals and which is coupled with a second phase shifter (MTV) to produce the downstream mixing signals, and in that the phase shifters are used in opposite manner on the first and second signals so that each of said first and second signals (VT1, VT2) receives the phase-advanced output signal from one of the two phase shifters and the phase-delayed output signal from the other of the two phase shifters.

2/ A bandpass filter device comprising two parallel processing paths (VT1, VT2) connected between the input (BE) and the output (BS) of the device, each path comprising a lowpass filter cell (F1, F2) located between an upstream mixer (MA1, MA2) and a downstream mixer (MV1,

MV2), and transposition means (LO, MTM, MTV) delivering two respective upstream mixing signals which are substantially in phase quadrature to the upstream mixers (MA1, MA2), and two respective downstream mixing signals which are substantially phase quadrature to the downstream mixers (MV1, MV2), the device further comprising an adder or a subtracter (STM) connected to the outputs from the downstream mixers, transposition means being provided to deliver the downstream mixing signals at a selected frequency ( $\omega_1$ ) different from the frequency of the upstream mixing signals ( $\omega_2$ ) in such a manner that the output signal from the band-pass filter is transposed into a desired frequency range, the device being characterized in that it comprises a common oscillator (LO) coupled with a first phase shifter (MTM) for producing the upstream mixing signals and coupled with a second phase shifter (MTV) for producing the downstream mixing signals, and in that the phase shifters are connected in opposite manner so that each of the two parallel branches (VT1, VT2) receives the phase-advanced output signal from one of the two phase shifters and the phase-delayed output signal from the other of the two phase shifters.

3/ A device according to claim 2, characterized in that the ratio between the frequency of the upstream mixing signals ( $\omega_0$ ) and the frequency of the downstream mixing signals ( $\omega_1$ ) is equal to an integer ratio.

4/ A device according to claim 2 or claim 3, characterized in that the two phase shifters are constituted by circuits each presenting a cutoff frequency between their two phase-shifted outputs that is equal respectively to the frequency of the upstream mixing signals ( $\omega_0$ ) for the first phase shifter (MTM) and to the frequency of the downstream mixing signals ( $\omega_1$ ) for the second phase shifter (MTV).

5/ A device according to any one of claims 2 to 4, characterized in that it comprises an oscillator (LO) coupled to a first phase shifter (MTM) formed by an RC-CR circuit to deliver the upstream mixing signals, and an oscillator (LO) coupled to a second phase shifter (MTV) formed by a second RC-CR circuit to deliver the downstream mixing signals.

10 6/ A device according to claim 5, characterized in that the capacitors (C, C') of the first and second RC-CR circuits have the same capacitance value and the resistance values of said circuits are selected so that the ratio (n) of the value of the resistances of the second RC-CR circuit over the value of the resistances of the first RC-CR circuit is equal to the ratio (n) of the frequency of the upstream mixing signals ( $\omega_0$ ) over the frequency of the downstream mixing signals ( $\omega_1$ ).

15 7/ A device according to claim 5, characterized in that the resistors (R, R') of the first and second RC-CR circuits present the same resistance value, and the capacitors (C, C') of said RC-CR circuits are selected so that the ratio (m) of the capacitance values of the second RC-CR circuit over the capacitance value of the first RC-CR circuit is equal to the ratio (m) of the frequency of the upstream mixing signals ( $\omega_0$ ) over the frequency of the downstream mixing signals ( $\omega_1$ ).

20 8/ A device according to claim 5, characterized in that the capacitors (C, C') of the first and second RC-CR circuit have capacitance values in a ratio equal to an integer ratio, and in that the resistors (R, R') of the first and second RC-CR circuits present resistance values in a ratio equal to an integer ratio.

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9/ A device according to any one of claims 5 to 8, characterized in that the RC-CR circuits are disposed in opposite manner so that each of the two parallel branches (VT1, VT2) receives the phase-advanced output signal from 5 one of the two RC-CR circuits and the phase-delayed output signal from the other of the two RC-CR circuits.

10/ A device according to any one of claims 2 to 9, in combination with claim 4, characterized in that the 10 oscillator (LO) is coupled to one of the first and second phase shifters (MTM, MTV) via at least one frequency transposition means.

## A B S T R A C T

## A BANDPASS FILTER WITH CARRIER FREQUENCY REDUCTION

5        The invention provides a bandpass filtering method in which two frequency transpositions are performed in parallel on an input signal (SE) for filtering using respective first and second upstream mixing signals (SM1, SM2) that are substantially in phase quadrature so as to obtain respective first and second transposed signals (ST1, ST2), and the two transposed signals are filtered respectively by two lowpass filters (F1, F2), the frequency of the transposition signals ( $\omega_0$ ) and the passband (B/2) of the low-pass filters being related to the frequency of the input signal ( $\omega_e$ ) and to the passband desired for the bandpass filter, then respective frequency transpositions are performed on the first and second filtered transposed signals (STF1, STF2) using two respective downstream mixing signals, and the sum or the difference of the two signals obtained in this way is taken, the frequency of the output mixing signals (SMV1, SMV2) is selected to be different from the frequency of the first and second mixing signals so that the output signal is transposed into a desired frequency range, the method being characterized in that a common oscillator (LO) is used which is coupled with a first phase shifter (MTM) to produce the upstream mixing signals and which is coupled with a second phase shifter (MTV) to produce the downstream mixing signals, and in that the phase shifters are used in opposite manner on the first and second signals so that each of said first and second signals (VT1, VT2) receives the phase-advanced output signal from one of the two phase shifters and the phase-delayed output signal from the other of the two phase shifters.

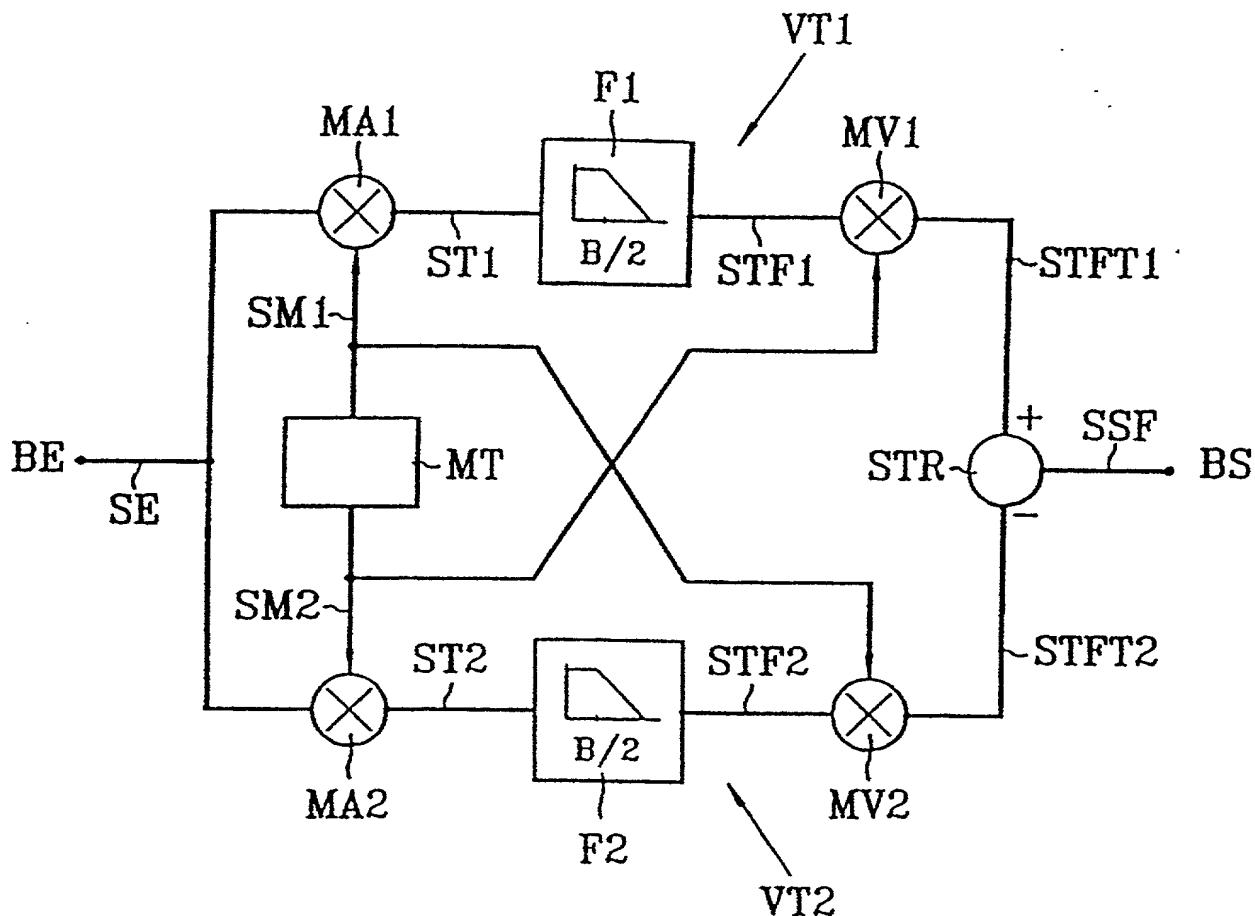
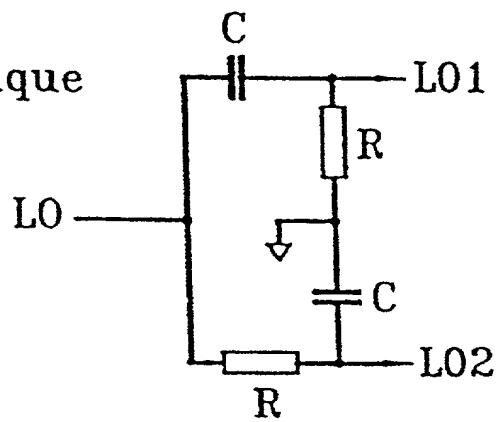
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Translation of the title and the abstract as they were when originally filed by the Applicant. No account has been taken of any changes that may have been made subsequently by the PCT Authorities acting ex officio, e.g. under PCT Rules 37.2, 38.2, and/or 48.3.

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FIG. 1

Etat de la technique

FIG. 2  
Etat de la technique

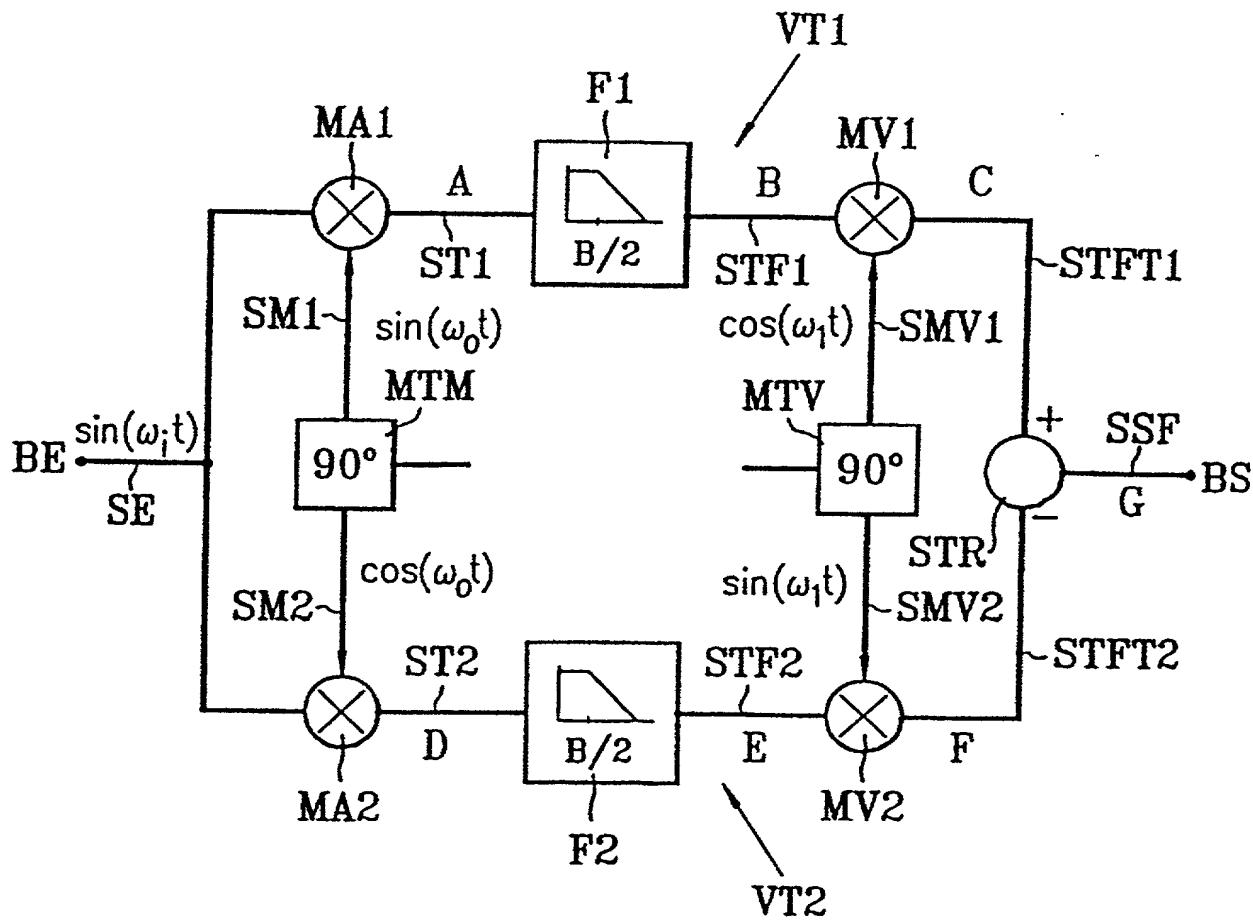
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FIG. 3

FIG. 4

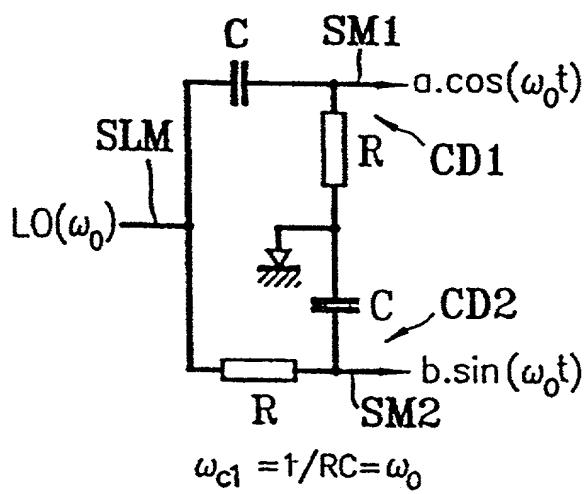
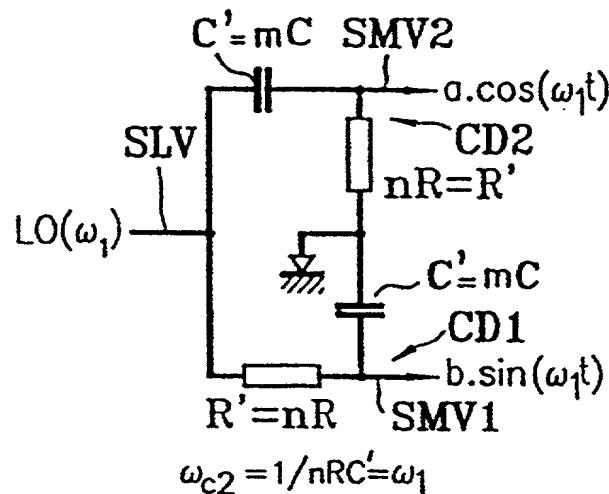


FIG. 5



PCT/FR00/01448  
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(Filing Date)

(Application Serial No.)

(Filing Date)

Pending  
(Status - patented, pending, abandoned)

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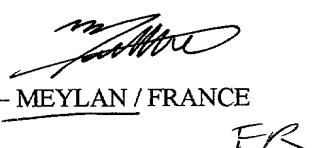
I hereby appoint BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, a firm including :

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(City, State)

Citizenship:

(Country)

Post Office Address:

Full Name of Third/Joint Inventor:



Our ref.: 15675. P382

## DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

[M2] **A bandpass filter with carrier frequency reduction**

the specification of which

is attached hereto  
was filed on **May 26, 2000** as  
Application Serial No. **PCT/FR00/01448**  
And was amended on  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section 199, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor(s) certificate having a filing date before that of the application on which priority is claimed:

<b>Prior Foreign Application(s)</b>			<b>Priority Claimed</b>	
99 06710 (Number)	FRANCE (Country)	May 27, 1999 (Day/Month/Year Filed)	X Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.